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RESEARCH ARTICLE

Relationship between BMI at Discharge and ADL Ability in Integrated Community Care Ward

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Abstract

Objective: Low BMI is a poor prognostic factor. Previous studies have reported that daily body activity (ADL) ability is difficult to improve if the body mass index (BMI) at admission is low, but the relationship between BMI at discharge and ADL ability has not been clarified. Therefore, we aimed to clarify that ADL ability is low when BMI at discharge is low.

Subjects and methods: A cross-sectional study of patients who were admitted to an integrated community care ward and underwent rehabilitation. Patient information was investigated from medical records. BMI: Less than 20 kg/m^2 was defined as a low BMI group, and more than that was defined as a non-low BMI group. The survey items were compared between groups and at the time of hospitalization. We also investigated the relationship between functional independence rating scale (FIM) gain and discharge BMI by multiple regression analysis.

Results: The number of subjects was 200, 103 in the low BMI group, and 97 in the non-low BMI group. The low BMI group had a lower total FIM score and total FIM gain than non-low BMI, and BMI was low since admission ($p < 0.05$). Multiple regression analysis showed that discharge BMI was independently positively related to total FIM gain ($p < 0.05$).

Conclusion: It was suggested that BMI may be related to the improvement of ADL ability.

Keywords

Integrated community care ward, Elderly, BMI at discharge, FIM gain

Introduction

Inpatients have a low proportion of low body weight, which is a poor prognostic factor. In a review paper surveying the proportion of undernutrition among inpatients, 31% of inpatients are undernourished, and undernutrition adversely affects mortality, morbidity, dysfunction, hospitalization, and health care costs has been reported [1]. Research reports in Japan also show that BMI at admission is related to improvement of activity of daily living (ADL) and that ADL ability is difficult to improve if there is a risk of undernutrition at admission [2,3]. Furthermore, in a study targeting a integrated community care ward, low nutrition risk patients are reported to have low ADL ability and a factor that prevents them from returning home [4]. In addition, more than half of the patients at the same ward are at risk of undernutrition [4]. These results indicate that hospitalized patients have a high proportion of undernutrition at the time of admission, and that undernutrition prevents improvement of ADL ability and return to home.

However, these reports evaluated the nutritional status at the time of hospitalization, and the progress during hospitalization and the status at discharge were not clarified. Undernutrition at discharge indicates that nutritional status did not improve during hospitalization or that nutritional status deteriorated. In a study using the nutritional status at admission as an index, it is unclear how the nutritional status changed from hospitalization to discharge and whether the change in nutritional status was associated with improved ADL ability. Rehabilitation outcomes have been reported to be good if the nutritional status at admission is good [5], but few reports have investigated the relationship between nutritional status during admission and ADL ability. Therefore, investigating the relationship between

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nutritional status at discharge and ADL ability is a significant outcome in suggesting that improving nutritional status during hospitalization is a necessary element for improving ADL capacity.

The importance of rehabilitation nutrition in integrated community care ward is not clear because there are few previous studies. The Community Comprehensive Care Ward has three roles: (1) Acceptance from the acute phase, (2) Acceptance in an emergency, and (3) Support for returning home, and the hospitalization deadline is set at 60 days. In contrast to the convalescent rehabilitation ward, the community comprehensive care ward has no target disease. Therefore, in order to fulfill the above three roles in a period of 60 days, it is necessary to deal with patients in various states different from those in the convalescent rehabilitation ward. However, in previous studies, there were many reports targeting convalescent rehabilitation wards and few reports targeting integrated community care ward.

The purpose of this study was to investigate the relationship between nutritional status and ADL ability at the time of discharge in elderly patients admitted to the integrated community care ward.

Material and Method

Subject

Patients who had been admitted to the Community Comprehensive Care Ward of Hospital A during the period from April 2017 to April 2018 and performed rehabilitation. Exclusion criteria included patients under 70 years of age, patients who were discharged from the hospital, patients who were transferred to an emergency hospital, and patients whose survey items were deficient. The subjects were rehabilitated 6 days a week for 40 to 60 minutes per day.

Method

The study design was a cross-sectional study, and retrospectively from the medical record, age, sex, disease, height, weight at hospitalization and discharge, BMI, Functional Independence Measure (FIM), serum albumin level, C-reactive Protein (CRP) Charlson comorbidity index (CCI), Food Intake Level Scale (FILS) at admission, required energy, intake energy, energy sufficiency, hospitalization days, hospitalization origin, discharge destination were collected.

Body weights were measured by nurses within one week of hospitalization and within one week before discharge. The BMI values at the time of hospitalization and discharge were calculated using the weight values. In this study, BMI was used as an indicator of nutritional status [6].

FIM is a score of the degree of independence in daily life, and is scored in 7 stages from 1 point "all assistance" to 7 points "independence". It consists of 13 items related to exercise and 5 items related to cognition, a total of 18 items, with a maximum of 126 points and a minimum of 18 points. FIM scores were scored by each therapist at the time of hospitalization and discharge. FIM was divided into motor FIM, cognitive FIM, and total FIM, and the change from hospitalization to discharge was calculated by subtracting the score at hospitalization from the score at hospital discharge.

CCI is a score assigned to each comorbidity, and the score is added according to the comorbidity [7]. CCI was calculated by therapist investigating comorbidities from medical records.

FILS is an index that shows the eating situation in 10 stage from level 1 to level 10. The higher the score, the better the eating situation [8]. FILS was evaluated by a registered dietitian at the time of admission.

The amount of energy required was calculated using the Harris-Benedict equation. The stress coefficient was set by a registered dietitian considering the general condition of the case based on the report of Long, et al. [9]. The activity coefficient was set by the assigned therapist. Regarding the activity coefficient, the activity amount in daily life and the activity amount during each therapy were judged in three stages, low, medium and high, respectively, and a coefficient of 1.1 to 1.7 was set. At each stage of daily activity, low is "always bedded", middle is "only rehabilitation and ADL activities are performed", and high is "rehabilitation and ADL other than self-training activities". The amount of activity during each therapy is low, "assistance in the supine position, sitting position to automatic exercise level exercise", medium, "exercise in antigravity position, low level strength training", high, "walking, Active exercise such as strength training".

The amount of energy consumed was calculated by the dietitian who extracted the rate of meal intake for one week from the hospitalization of each patient from the medical record and multiplied the amount of energy provided and the rate of intake to calculate the average amount of energy consumed. The energy sufficiency rate was calculated by the registered dietitian as the ratio of the intake energy amount to the required energy amount. The number of days of hospitalization was the number of days in the integrated community care ward.

The criteria for undernutrition were classified into two groups, with a BMI of less than 20 kg/m^2 at discharge as a low BMI group and a non-low BMI group at 20 kg/m^2 or more with reference to the GLIM undernutrition standard [10].

Statistical analysis

The Shapiro-Wilk test was performed as a test of normality for all survey items, and subsequent tests were selected based on the results. To examine the difference between the low BMI group and the non-low BMI group, based on the test of normality, if the normal distribution is followed, the unpaired t-test, otherwise the Mann-Whitney U test Was performed. In addition, we performed χ^2 test for the binary variable items. To examine the progress during hospitalization in the low BMI group, BMI, albumin level, CRP, motor FIM, cognitive FIM, and total FIM measured at the time of hospitalization and discharge are each assigned a t-test or Wilcoxon rank test was performed.

Finally, we conducted a multiple regression analysis using FIM gain as the objective variable, and examined the strength of the relationship between changes in FIM and BMI at discharge. The explanatory variables of the multiple regression analysis are as follows: Age, gender, admission BMI, discharge BMI, weight loss rate, discharge albumin level, discharge CRP, rehabilitation disease, CCI, energy sufficiency, FILS and the number of days of hospitalization were selected. When selecting explanatory variables, we confirmed multicollinearity. The multicollinearity was judged as a correlation scale | r | 0.8 or more, and the variables considered clinically significant were adopted when the multicollinearity was confirmed. Statistical processing was performed using Excel statistics, with a statistical significance level of less than 5%.

Ethical considerations

This study was approved by the Ethics Committee at Sakurajyuji Hospital (approval number: 2019-02). In conducting the retrospective survey, we made the data obtained anonymous so that no personal information was identified.

Result

Basic attributes (Table 1)

During the study period, the total number of patients admitted to the integrated community care ward was 336 patients (122 men, 214 women), and 136 patients met the exclusion criteria (42 patients under 70 years old, 18 patients died, 9 patients emergency transfers, 67 patients with data loss).

After applying the exclusion criteria, the number of subjects analyzed was 200 patients, and the mean age was 86.3 ± 6.2 years, 64 men and 136 women. Among them, the low BMI group was 103 patients, the average age was 86.7 ± 5.8 years old, 38 men, 65 women, and the non-low BMI group was 97 patients, the average age was 85.9 ± 6.7 years old, 26 men, 71 women.

In the low BMI group, hospitalization from the outpatient was the most frequent, and in the non-low

Table 1: Patient characteristics and comparison between low and non-low BMI groups.

Patient characteristics	Total (n = 200)	Low BMI group (n = 103)	Non-low BMI group (n = 97)	p-value
Age (years)	87 (83-91)	87 (83-91)	86 (83-90)	0.412
Gender (person)	Male: 64 (32%) Female: 136 (68%)	Male: 38 (37%) Female: 65 (63%)	Male: 26 (27%) Female: 71 (73%)	0.127
Weight at admission (kg)	44.5 (38.3-51.4)	39.9 (34.6-44.2)	51.0 (45.2-55.7)	< 0.001
Body weight at discharge (kg)	44.0 (38.1-51.7)	39.3 (35.5-43.4)	51.7 (45.8-55.6)	< 0.001
BMI at admission (kg/m^2)	19.6 (17.3-22.1)	17.4 (15.8-18.7)	22.1 (20.6-23.7)	< 0.001
BMI at discharge (kg/m^2)	19.8 (17.2-21.9)	17.3 (15.8-18.4)	21.9 (20.8-23.5)	< 0.001
Weight loss rate (%)	0.1 (-2.9-3.8)	1.1 (-3.2-5.6)	0.0 (-2.5-2.8)	0.217
Albumin level on admission (mg/dl)	3.4 (3.0-3.7)	3.2 (2.9-3.6)	3.4 (3.1-3.8)	0.011
Albumin level at discharge (mg/dl)	3.3 (2.9-3.6)	3.2 (2.9-3.5)	3.3 (3.1-3.7)	0.003
CRP on admission (mg/dl)	1.09 (0.21-4.4)	1.34 (0.34-5.09)	0.78 (0.18-4.27)	0.146
CRP at discharge (mg/dl)	0.40 (0.12-1.5)	0.67 (0.18-1.87)	0.30 (0.10-1.02)	0.017
CCI	2 (1-4)	2 (2-4)	2 (1-4)	0.181
Required energy (kcal)	1437 (1286-1595)	1383 (1254-1537)	1485 (1311-1657)	0.002
Intake energy (kcal)	1254 (960-1590)	1200 (800-1500)	1280 (1025-1600)	0.046
Energy satisfaction rate (%)	85.1 (67.5-101.8)	84.0 (64.0-110.3)	85.5 (77.8-98.7)	0.354
FILS	8 (7-10)	8 (6-10)	9 (8-10)	0.022
Number of hospitalization days	56 (42-59)	56 (42-59)	55 (42-59)	0.983
Hospitalization origin (person)	Outpatient: 83 (41.5%) Acute Hospital: 60 (30%) Clinic: 27 (13.5%) Non-Acute Hospital: 19 (9.5%) Others: 11 (5.5%)	Outpatient: 47 (46%) Acute Hospital: 23 (22%) Clinic: 19 (18%) Non-Acute Hospital: 7 (7%) Other: 7 (7%)	Outpatient: 36 (37%) Acute Hospital: 37 (38%) Clinic: 8 (8%) Non-Acute Hospital: 12 (13%) Other: 4 (4%)	0.025

Discharge destination (person)	Residential nursing home for the elderly: 75 (37.5%) Home: 66 (33%) Transfer to the disabled ward: 17 (8.5%) Home facility: 12 (6%) Transfer to the medical ward: 8 (4%) Other: 22 (11%)	Residential nursing home for the elderly: 40 (39%) Home: 28 (27%) Transfer to the disabled ward: 12 (11%) Home facility: 6 (6%) Transfer to the medical ward: 7 (7%) Other: 10 (10%)	Residential nursing home for the elderly: 35 (36%) Home: 38 (39%) Relocated to the disabled ward: 5 (5%) 6 home-based facilities (6%) Relocated to the medical ward: 1 (1%) Other: 12 (13%)	0.099
Disease (person)	Disuse syndrome: 75 (37.5%) Respiratory disease: 53 (26.5%) Motor organ disease: 50 (25%) Heart disease: 22 (11%)	Disuse syndrome: 32 (31%) Respiratory disease: 31 (30%) Motor organ disease: 28 (27%) Heart disease: 12 (12%)	Disuse syndrome: 43 (44%) Respiratory disease: 22 (23%) Motor organ disease: 22 (23%) Heart disease: 10 (10%)	0.276
Exercise FIM (points) on admission	37 (16-66)	32 (15-61)	43 (20-67.5)	0.059
Cognitive FIM at admission (point)	21 (12-31)	19 (11-29)	24 (14-33)	0.025
Total FIM at admission (points)	58 (30-94)	48 (26-92)	70 (35-98.5)	0.038
Exercise FIM (points) at discharge	55 (20-78)	41 (18-75)	64 (27-82)	0.005
Cognitive FIM at discharge (point)	23 (12-32)	20 (11-29)	27 (14-33)	0.015
Total FIM at discharge (points)	76 (32-110)	63 (29-105)	90 (42-113)	0.005
Motor FIM gain (point)	5 (1-13)	4 (0-11)	7 (1-15)	0.011
Cognitive FIM gain (points)	0 (0-1)	0 (0-1)	0 (0-1)	0.499
Total FIM gain (points)	6 (1-13)	4 (0-11)	8 (2-16)	0.016

median (25%, 75%)

BMI: Body Mass Index; CRP: C-Reactive Protein; CCI: Charlson Comorbidity Index; FILS: Food Intake Level Scale; FIM: Functional Independence Measure.

BMI group, the most frequent hospitalization was from the acute care hospital. In the low BMI group, the number of residential-type paid nursing homes was the highest, and the non-low BMI group was home the most. The breakdown of the disease was mostly disused syndrome (Table 1).

Comparison between groups (Table 1)

Comparison of the survey items between the low BMI group and the non-low BMI group was as follows: BMI at admission, albumin level at admission, energy requirement, energy intake, FILS, total FIM at admission, cognitive FIM at admission, total FIM at discharge, Motor FIM at discharge, cognitive FIM at discharge, total FIM gain, motor FIM gain were significantly lower in the low BMI group, and discharge CRP was significantly higher in the low BMI group.

Comparison between admission and discharge (Table 2)

A comparison between admission and discharge at all subjects showed significant differences in CRP, motor FIM, and total FIM ($p < 0.01$).

Comparison between admission and discharge in the low BMI group showed significant differences in BMI, CRP, motor FIM, cognitive FIM, and total FIM ($p < 0.05$). In the non-low BMI group, CRP, motor FIM, and total FIM were significantly different. From hospitalization to discharge, BMI increased in 87 (44%) and decreased in 100 (50%). During hospitalization, 11 (11.2%) had a BMI of less than 20 kg/m^2, and 10 (9.8%) had a BMI of 20 kg/m^2 or more (Table 2).

Multiple regression analysis (Table 3)

In predisposal of the multiple regression analysis, | r | accepted more than 0.8 and multicollinearity to BMI at on admission BMI and a discharge. Therefore, we selected BMI at discharge as an explanatory variable in this study. For total FIM gain, BMI at discharge (β = 0.178; 95% CI = 0.161 to 1.330, p = 0.013), albumin level at discharge (β = 0.193; 95% CI = 1.024 to 10.462, p = 0.017), Number of hospitalization days (β = 0.158; 95% CI = 0.025 to 0.312, p = 0.022) was extracted (R^2 = 0.134) (Table 3).

Discussion

These results indicate that patients with low BMI at discharge have lower ADL capacity and improve-

Table 2: Comparison between admission and discharge.

Survey item	Overall (n = 200)			Low BMI group (n = 103)			Non-low BMI group (n = 97)		
	When hospitalized	At discharge	p-value	When hospitalized	At discharge	p-value	When hospitalized	At discharge	p-value
BMI (kg/m^2)	19.6 (17.3-22.1)	19.8 (17.2-21.9)	0.782	17.4 (15.8-18.7)	17.3 (15.8-18.4)	0.039	22.1 (20.6-23.7)	21.9 (20.8-23.5)	0.935
Albumin level (mg/dl)	3.4 (3.0-3.7)	3.3 (2.9-3.6)	0.098	3.2 (2.9-3.6)	3.2 (2.9-3.5)	0.074	3.5 (3.1-3.8)	3.3 (3.1-3.7)	0.181
CRP (mg/dl)	1.09 (0.21-4.4)	0.40 (0.12-1.5)	< 0.001	1.34 (0.34-5.09)	0.67 (0.18-1.87)	0.002	0.78 (0.18-4.27)	0.30 (0.10-1.02)	< 0.001
Exercise FIM (point)	37 (16-66)	55 (20-78)	0.001	32 (15-61)	41 (18-75)	< 0.001	43 (20-68)	64 (27-82)	0.003
Cognitive FIM (point)	21 (12-31)	23 (12-32)	0.684	19 (11-29)	20 (11-29)	0.006	24 (14-33)	27 (14-33)	0.706
Total FIM (points)	58 (30-94)	76 (32-110)	0.006	48 (26-92)	63 (29-105)	< 0.001	70 (35-99)	90 (42-113)	0.010

BMI: Body Mass Index; CRP: C-Reactive Protein; FIM: Functional Independence Measure.

ment at admission than patients with lower BMI, and BMI at discharge is independent of the improvement in ADL capacity. In addition, it was found that patients with low BMI at discharge had low BMI at hospital admission, and BMI was difficult to improve during hospitalization.

First, patients with low BMI at discharge were independently related to improvement in ADL ability. Previous studies have reported that when the BMI at admission is low, the ADL ability at admission and its improvement is low. Nakazawa, et al. investigated the BMI and prognosis of 8510 elderly people entering the facility, and reported that the lower the baseline BMI, the lower the ADL ability [11]. Naruishi, et al. investigated the relationship between BMI and ADL ability in 1223 elderly inpatients in acute hospitals, and reported that FIM gain and FIM efficiency were low when BMI was low [12]. In this study, patients with a low BMI at discharge had a lower FIM gain than patients with a low BMI. A low BMI indicates that the components of body composition, including muscle mass, are low. Therefore, low BMI may be associated with lower physical function levels. Minematsu, et al. conducted a cross-sectional study of the relationship between BMI and physical function in 3549 community-dwelling elderly people in Japan over 65-years-old. When BMI is low, grip strength, knee extension torque, and knee flexion torque are low [13]. Ferreira, et al. conducted a cross-sectional study on the relationship between BMI and physical functioning in 316 community-dwelling elderly, and reported that when the BMI was low, the results of the chair standing test were low [14]. Based on the above, there is an association between BMI and physical function. Physical function has been associated with ADL ability. den Ouden, et al. investigated the relationship between physical function and ADL ability in 625 elderly people living in the region, and reported that ADL ability decreases when grip strength, lower limb strength, and physical activity are low [15]. Although the physical function was not investigated in this study, the low BMI group had a low BMI even during hospitalization, which may have reduced the physical function. Therefore, it can be considered that the improvement in ADL ability was lower than that in the non-low BMI group due to decreased physical function in the low BMI group.

Second, patients with low BMI on discharge had low BMI on admission, and BMI was difficult to improve during hospitalization. There are two possible reasons why BMI was difficult to improve. First, it is thought that the nutrition support provided to each patient was insufficient and the energy intake was insufficient. Bally, et al. Conducted a meta-analysis of the effects of nutrition support on undernourished patients and reported that nutrition support increas-

Table 3: Multiple regression analysis with total FIM gain as objective variable.

factor	Standard partial regression coefficient (β)	95% CI	p-value	VIF
Age	-0.055	-0.444-0.188	0.435	1.103
Sex	0.064	-2.218-6.174	0.313	1.097
BMI at discharge	0.168	0.123-1.285	0.013	1.148
Weight loss rate	-0.066	-0.399-0.134	0.329	1.034
Albumin level at discharge	0.196	1.156-10.475	0.017	1.492
CRP at discharge	-0.093	-1.283-0.306	0.217	1.364
Rehabilitation	-0.021	-1.831-1.334	0.757	1.068
CCI	-0.012	-1.004 -0.843	0.772	1.088
Energy sufficiency	-0.132	-0.146-0.003	0.061	1.128
FILS	0.073	-0.403-1.268	0.312	1.192
Hospitalization days	0.157	0.026-0.312	0.022	1.056

R^2 = 0.134.

BMI: Body Mass Index; CRP: C-Reactive Protein; CCI: Charlson Comorbidity Index; FILS: Food Intake Level Scale; FIM: Functional Independence Measure.

es body weight, energy intake, and protein intake [16]. On the other hand, Rasheed, et al. Investigated the effects of nutritional support on undernourished patients in 126 inpatients over 60 years of age, and 76% of patients did not improve nutritional status even after receiving nutritional support [17]. In this study, there was no difference in the energy sufficiency rate or energy intake during admission between the low BMI group and the non-low BMI group, but the median energy sufficiency rate was less than 100% in both groups. The BMI did not change during the hospital stay. Therefore, insufficient intake of energy at the time of hospitalization may be one of the factors that prevented BMI from improving. Second, the low BMI group may have a poorer general condition than the non-low BMI group. In this study, CRP at admission tended to be higher in the low BMI group, and CRP at discharge was significantly higher in the low BMI group. Regarding the relationship between BMI and CRP, previous studies have produced results that differ from this study. A systematic review by Fedewa, et al. shows that BMI and CRP are positively correlated [18]. Qin, et al. in 6091 healthy middle-aged and elderly people showed that CRP was lower in the low BMI group than in the obese group, and was not different from the normal weight group [19]. These results suggest that when BMI is high, CRP is also high. In this study, the CRP was high in the low BMI group. This may be related to disease-induced inflammation. Rasheed, et al. suggested that severe cases were included as a factor that nutritional status did not improve after nutrition support [17]. In this study, CRP in the low BMI group exceeded the reference value (0.3 mg/dl or less), and the median CCI was 2 points, so there may be many severe cases with comorbidities. Based on the above, it is possible that BMI was difficult to improve during hospitalization because it was related to poor general condition.

This study has three limitations. The first is that this study is a cross-sectional study, so we cannot mention causality. The lower BMI at discharge, the improvement in physical function may be low, and it may be difficult to improve the ADL ability. In addition, the low ADL ability is a condition in which food and excretion cannot be sufficiently performed, so the food intake may have decreased and the BMI may have decreased. Second, there is a possibility that a confounding factor that has not been investigated this time exists between BMI and ADL ability at discharge. In this study, each item was examined retrospectively from the medical record, but only the information obtained from the medical record could be investigated. Therefore, items that could not be investigated may have an influence as a confounding factor. In the forced input method in multivariate analysis, explanatory variables are selected with reference to previous studies, but the coefficient of determination adjusted for degrees of freedom is as low as 0.134, so there is a possibility that factors that were not selected are related. The third point is that this data is for a single facility. Since the data is for a single facility, the characteristics of the facility or region may affect the characteristics and results of the target person.

Conclusion

The results show that when BMI is low at discharge, ADL ability at the discharge and improvement in ADL ability are low compared to non-low BMI patients, and patients with low BMI at discharge are also hospitalized. It was revealed that BMI was low and that BMI at discharge was independently related to the improvement of ADL ability, suggesting that nutritional status may affect the improvement of ADL ability. In the future, it will be necessary to increase the number of subjects and investigate the causal relationship between ADL ability and nutritional status.

Conflicts of Interest

There are no author conflicts of interest regarding this paper.

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